

KAUA'I WATERSHED MANAGEMENT PLAN

Overall Management Strategy

April 2005



PREPARED BY THE KAUA'I WATERSHED ALLIANCE

Upper Wainiha Valley, Kaua'i

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Executive Summary

In 2003, the Kaua'i Watershed Alliance (KWA) was formed. The members include the major landowners within the conservation district (or forest reserve) boundary on the island of Kaua'i: Department of Water of the County of Kaua'i; the Department of Land and Natural Resources of the State of Hawai'i, via its Division of Forestry and Wildlife, Division of State Parks, and its Land Management Division; Kamehameha Schools; McBryde Sugar Company, Ltd.; Grove Farm Company, Incorporated; Lihu'e Land Company; Kealia Ranch, LLC; B.A. Dyer, and Princeville Development, LLC. These members represent most of the landowners of the watershed of Kaua'i. The members of the partnership have different interests, priorities, and constituencies, but all share a common commitment - the long-term protection of Kaua'i's upper watershed areas.

The first protected forest reserves on Kaua'i were established at the turn of the 20th century and brought together government and private land managers in cooperative efforts. Now, more than a century later the KWA partners recognize that continuing cooperation is the key to a timely and successful watershed management program that will protect this region from invasive alien animals, plants, and other threats. Watershed Partnerships and Alliances are voluntary associations of public and private landowners and managers committed to the common value of protecting large areas of forested watersheds for water recharge and other benefits of intact forested ecosystems. More than 850,000 acres of important watershed areas in Hawai'i have entered into these unique public-private partnerships.

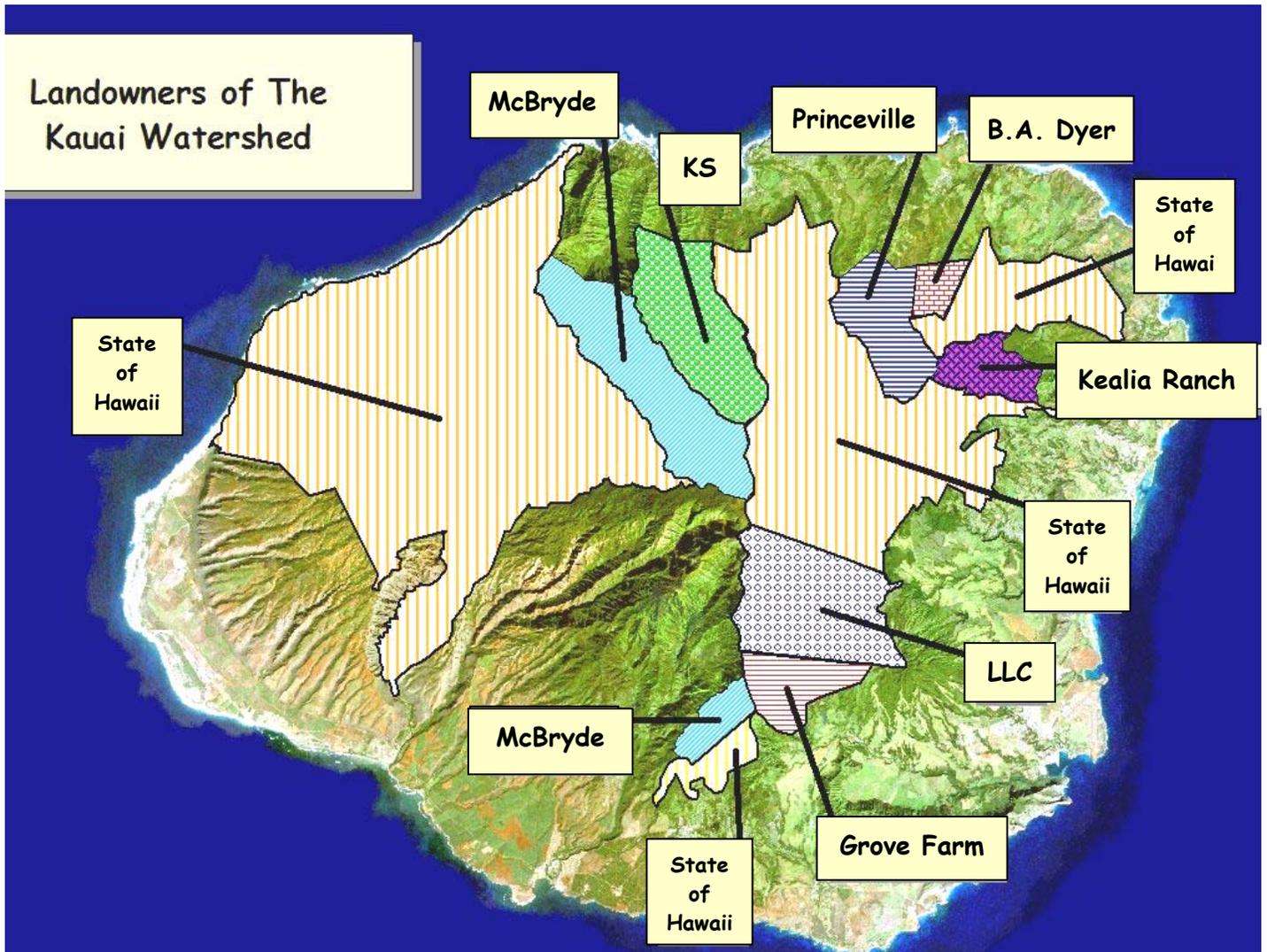


Figure 1. Landowners of the Kaua'i Watershed.

The value and service of Hawai'i's watersheds to the state's economy are commonly taken for granted. Forested watersheds provide us with nearly all our freshwater and contribute significantly to the natural beauty upon which our visitor industry depends. Native forest has deep Hawaiian cultural value recognized from the distant past to today. Kaua'i's forested watersheds are predominantly comprised of native plant communities, providing the majority of habitat for its world renowned biodiversity. This native watershed has been damaged by historical use and recent disturbance by major hurricanes and is in need of stabilization. The KWA contracted The Nature Conservancy through a grant from the Hawai'i Community Foundation and the Homeland Foundation to complete this plan within a year's time frame. Partner landowners and key stakeholders participated in questionnaires, interviews, discussions, and meetings leading to the identification and costing of the most important management actions. The plan presents the consensus interests and goals of the members of the KWA with feedback from key stakeholders and experts. It describes current watershed management programs and activities in the KWA area and recommends expansion of management to protect and sustain the core watershed areas.

This plan stresses the importance of active watershed management, and outlines the purpose, objectives, and budget of a comprehensive range of site management projects for the summit and upper slopes of Kaua'i's watershed. This plan describes prioritized programs in 1) Ungulate management, 2) Weed management, 3) Watershed monitoring, and 4) KWA infrastructure and budget. A detailed operational plan with timelines, infrastructure, and budgets is available and may be more useful in drafting watershed management funding proposals.



This spider of the Thomisidae family depends on the many ecological processes in the Kaua'i watershed.

Introduction and Background



The central highlands of Kauai represent a tremendous water resource for the island.

The Island of Kauai is the oldest of the main Hawaiian Islands. As a high island (reaching elevations in excess of 3,000 feet), it intercepts trade winds and receives significant rainfall in its windward and montane regions. The summit region of Kauai, near Wai'ale'ale, is arguably the wettest spot on Earth, and the central highlands of Kauai represent a tremendous water resource for the island. The vast majority of the central highlands is covered in native rainforests and associated ecosystems such as montane bogs and dense, wet shrublands. This vegetation extends downslope into lower regions. Streams run through all the districts of the island. The central highland area represents the Kauai watershed, and corresponds well

to the boundaries of the conservation district on Kauai.

In April 2003, nine state and private landowners officially formed the Kauai Watershed Alliance (KWA). The members of this partnership have different interests, priorities, and constituencies, but all share a common commitment - the long-term protection of Kauai's upper watershed. This combined area is shown in Figure 2.

The KWA partners continue to recognize that cooperation is the key to a timely and successful watershed management program that will protect Kauai's watershed from invasive alien animals, plants, and other threats.

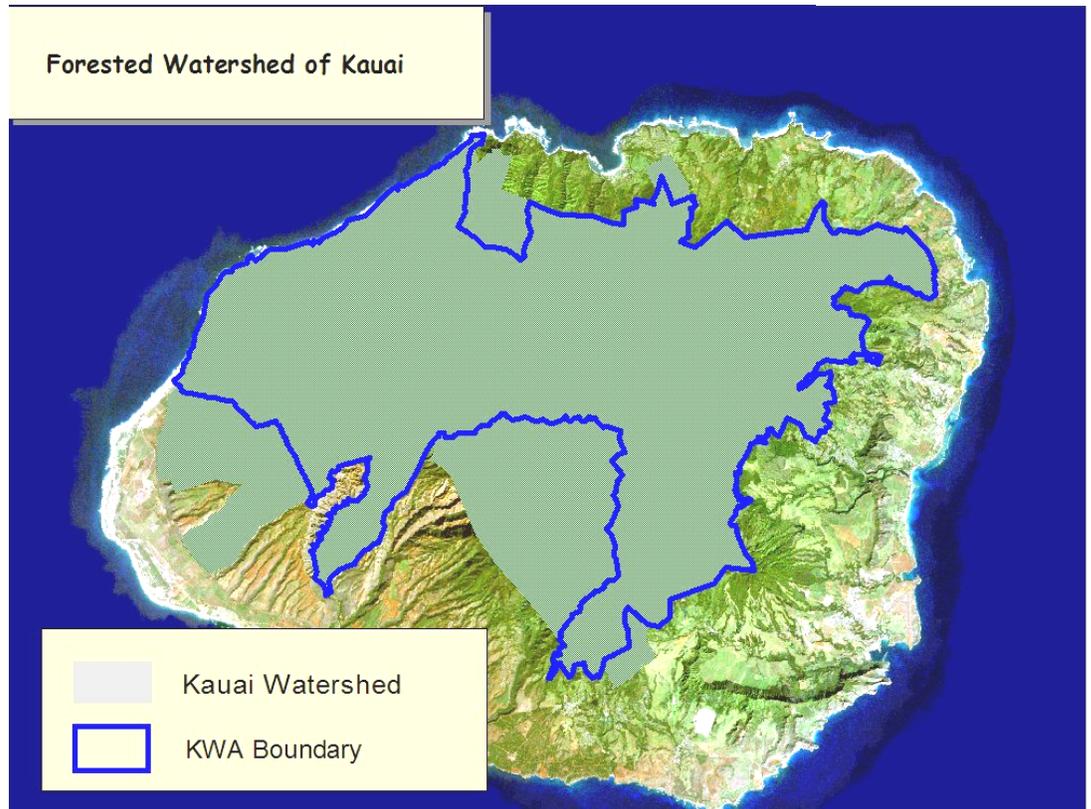


Figure 2. The members of the KWA include major landowners within the conservation district on the island of Kauai: Department of Water of the County of Kauai; the Department of Land and Natural Resources of the State of Hawaii, via its Division of Forestry Wildlife, Division of State Parks, and its Land Management Division; Kamehameha Schools; McBryde Sugar Company, Ltd.; Grove Farm Company, Incorporated; Lihu'e Land Company; Kealia Ranch, LLC; B.A. Dyer, and Princeville Development, LLC.

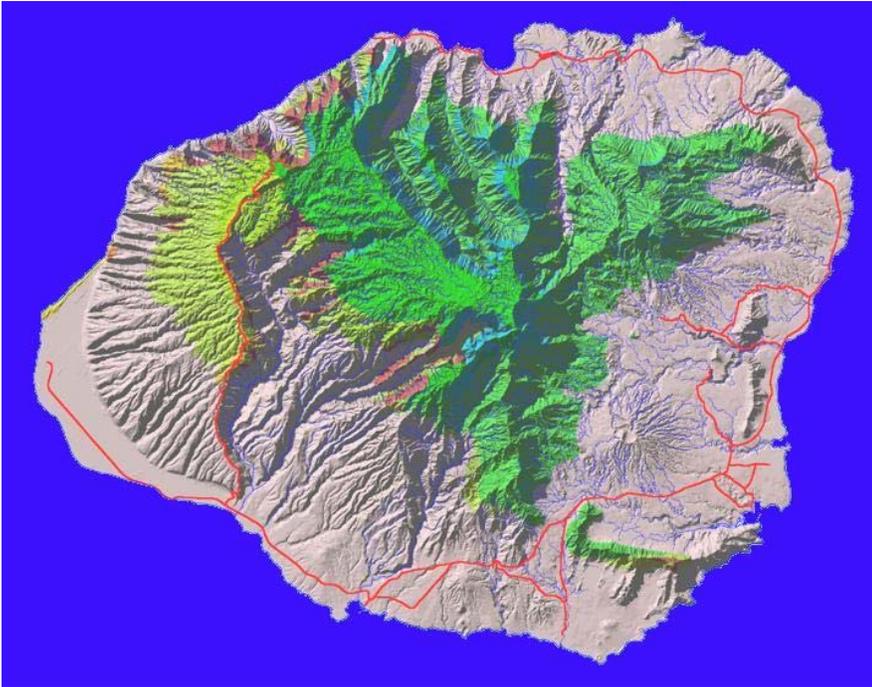


Figure 3. The watershed vegetation of Kaua'i (above) includes a core area of native montane and lowland wet forest (dark green), wet cliff vegetation (blue), and rich mesic forest (light green) that stabilize the island's rugged and steep terrain against erosion.



Intact lowland forest stands of Lumaha'i and Wainiha are biological gems – this forest type has been destroyed elsewhere in the islands and replaced by a mixed alien forest.

Native wet cliff vegetation offers an essential protection against erosion of the island's steepest terrain.



A rare lobelia, hāhā-'ai-aka-manu, grows at the edge of Kanaele, the only native lowland bog remaining in the islands.



The Unique Vegetation of the Kaua'i Watershed

As the oldest of the main Hawaiian Islands, the vegetation types of Kaua'i are distinctive; some are dominated by typical canopy trees, such as 'ōhi'a and koa, but include many species found only on the island of Kaua'i. Several of these natural communities are considered globally distinctive and imperiled (marked in red below), including a rich mesic forest type known only from Kaua'i, and the state's only example of a large, intact lowland bog:

Natural Communities of The Kaua'i Watershed

MONTANE:

- 'Ōhi'a / Uluhe Montane Wet Forest
- 'Ōhi'a / Mixed Shrub Montane Wet Forest
- 'Ōhi'a / Lapalapa Montane Wet Forest
- 'Ōhi'a Mixed Montane Bog
- Mixed Fern / Shrub Montane Wet Cliff

LOWLAND:

- 'Ōhi'a Lowland Wet Forest
- Mixed Fern / Shrub Lowland Wet Cliff
- 'Ōhi'a / Kuolohia Lowland Bog
- Uluhe Lowland Wet Shrubland
- Kaua'i Diverse Lowland Mesic Forest
- Lama / 'Ōhi'a Lowland Mesic Forest
- Koa / 'Ōhi'a Lowland Mesic Forest
- Koa Lowland Dry Forest
- 'A'alii Lowland Dry Shrubland
- Mixed Shrub Lowland Dry Cliff

Compared to the other islands, Kaua'i has maintained some remarkable examples of native vegetation in the lowland zone. The valley bottoms of Wainiha and Lumaha'i, as well as portions of east Kaua'i remain native-dominated. This represents a remarkable opportunity to protect native lowland watershed that has been entirely lost elsewhere in the islands.

Statewide Watershed Partnerships



Island watershed partnerships, including the KWA, formed the Hawai'i Association of Watershed Partnerships in 2003.



The native forest in Lumaha'i benefits from protection by the Kaua'i Watershed Alliance.

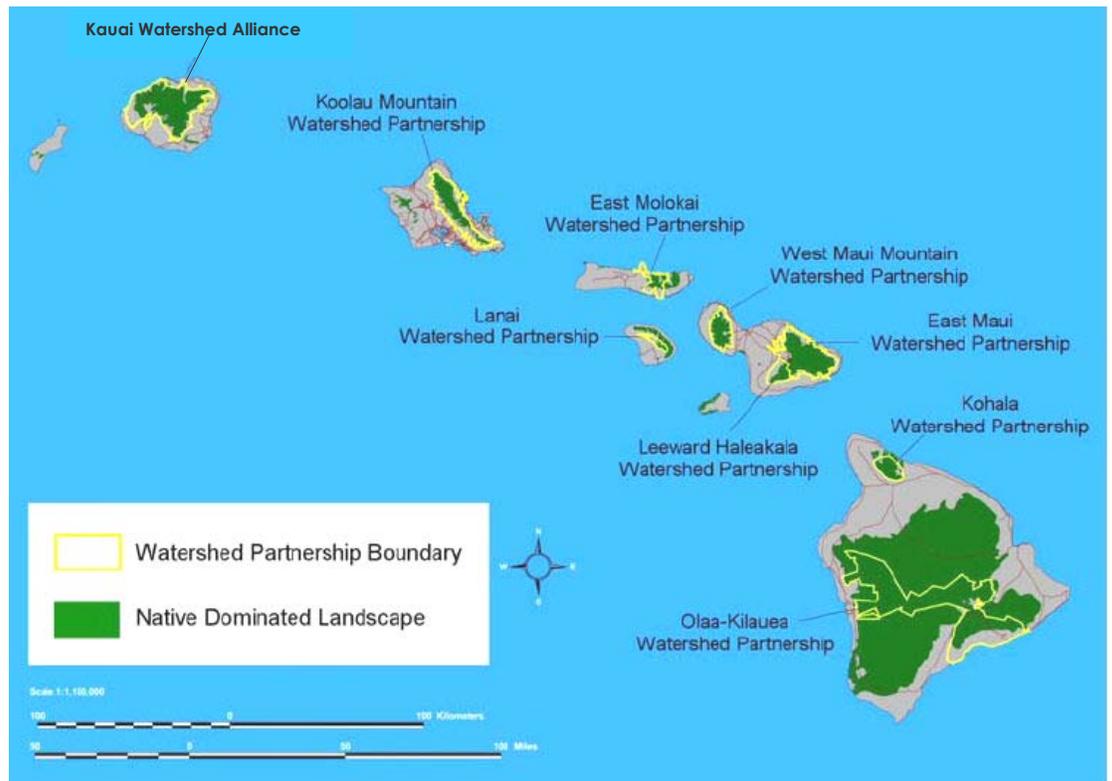
Watershed Partnerships and Alliances are voluntary associations of public and private landowners and managers committed to the common value of protecting large areas of forested watersheds for water recharge and other vital ecosystem services. More than 850,000 acres of important watershed areas in Hawai'i have been placed within these unique public-private partnerships (Figure 4).

In 1991, the first of the current watershed partnerships for large-scale forest protection was pioneered on East Maui. Today, after more than a decade of hard work, the East Maui partnership is a proven model for large-scale forest protection efforts in Hawai'i. Its success has spurred the formation of nine similar watershed partnerships across the island chain,

including the KWA. To better coordinate efforts, the island watershed partnerships, including the KWA, formed the Hawai'i Association of Watershed Partnerships in 2003.

In our efforts to save Hawaiian forested watersheds, these partnerships represent one of our best hopes for the future. Partnerships organized around common interests, such as watershed protection, yield a variety of benefits, including more efficient use of resources and staff; more comprehensive conservation planning; regional management actions that are conducted across land ownership boundaries; greater participation from landowners and the public; greater unity in lobbying efforts for public funding; and enhanced access to other funding opportunities.

Figure 4. Formed with a memorandum of understanding signed in 2003, the Kaua'i Watershed Alliance is similar to other watershed partnerships across the main Hawaiian Islands. The first such partnership was formed in 1991.



The Value of Forested Watersheds



Water (top) is the tangible resource derived when native species (center) interact to form stable watershed forests (bottom), which provide a wide variety of ecological services.

The value of Hawai'i's watersheds are vastly underestimated in terms of their service and contribution to the state's economy and the quality of life of residents and visitors.

Water

Forested watersheds provide several basic and crucial functions related to maintaining a source of high-quality water. The first is that of an umbrella. Tree leaves, branches, and understory plants intercept rain before it reaches the ground. The erosive, kinetic energy of falling rain is absorbed by the foliage, which reduces erosion and increases the infiltration of the rainwater into the ground.

Watershed forest also acts as a sponge, soaking up rainfall into its soil, leaf litter, mosses, ferns, and foliage, and slowing evaporation by shading the water-holding soil layers. Not only rainfall is absorbed in this way, but forest vegetation can also pull moisture from passing clouds that are not raining. Cloud and fog condensation on trees and other vegetation is an important source of water. Cloud and fog interception in Hawai'i can increase total precipitation by as much as 30% above the base annual rainfall.

When foliage, litter, and soil are fully saturated, they buffer the release of stored water, delivering a more consistent and dependable source of water for use, long after the rain has ceased falling. Thus, stream flows from intact, forested

watersheds are cleaner and more consistent during dry periods. In contrast, denuded watersheds are "flashy," sending floods of muddy water into streams during rain, and drying up rapidly when the rain stops.

Another function of a forest watershed is that of an entry valve into the groundwater cycle. The cool ground-level shade provided by intact forest and dense shrubland greatly suppresses the loss of water through evapotranspiration. This allows much of the rainfall and condensed fog drip to infiltrate into the ground, percolate through the soil, and enter ground water or stream systems as clean water.

Another major function of forested watershed is that of a soil anchor and filter. The roots of trees, shrubs, and associated understory plants grip the steep mountain soils tenaciously, and prevent soil from washing into our streams and oceans. This helps maintain clear, surface waters dependent on surface flow and also protects our ocean reefs and marine life from siltation.

Native Species and Ecosystems

Watershed partnerships and alliances have drawn attention to the important relationship between functioning watersheds and native Hawaiian ecosystems. The watershed vegetation of the KWA is habitat for thousands of native plants, birds, snails, insects and other invertebrates. Kaua'i contains 47% or 383 of the 813 endemic species of flowering plants



Material, intellectual, and spiritual benefits from Kaua'i's watershed forest remain important to the residents of Kaua'i.



of the entire archipelago, 55% of Hawai'i's endemic bird species, and 42% of the islands' natural communities. There are species and forms found only in the lands within the KWA area, and scientists estimate this area is home to an untold number of undescribed species.

Perhaps the greatest value of the thousands of native species in our upland forests is the function that they perform together, as part of a complex, natural ecosystem. The balance achieved over the millennia has produced forests that can best weather the typical cycles of drought and flood in the region, and are uniquely adapted to the climate and soils of the mountain. Native forest ecosystems provide the best chance for a stable watershed.

Native species and ecosystems also play a crucial role in Hawaiian cultural practices and in scientific research. Woodworking, weaving, cordage, herbal medicine, feather work, and lei-making remain important. The significance of native forest to Hawaiian culture also includes the intellectual and spiritual foundation of the Hawaiian worldview, based on ancient relationships between the people, gods, and the land.

The native forest is *wao akua* (the realm of the gods), and the realm of inspiration for the high arts of chant and hula.

Finally, there are few better natural laboratories than Hawai'i for the study of evolution, the role of individual species in an environment, and the complex relationships between organisms.

Other Resource Values

In a recent economic study*, the total value of native forest was estimated to be worth billions of dollars. Clearly, our forests are enormous economic assets. Just as clearly, the cost of maintaining them is not reflected in the price we pay for water and the other benefits they supply. Tourism, hunting, hiking, fishing, forestry, agriculture, and biotechnology are all industries that directly benefit from our forests.



Public support for protection of native forest is evidenced in a recent Mālama Hawai'i poll (2001) that showed 70% of respondents supported funding for increased watershed protection. Equally important, forest protection is merited on economic grounds. Protection of this natural resource facilitates economic development. A healthy watershed means a greater amount of groundwater and surface water for the state's residents and businesses. In addition, the world renowned beauty of Hawai'i's watershed areas and their recreational opportunities are one of the major draws of Hawai'i's number one industry - tourism.

* "Environmental Evaluation and the Hawaiian Economy," prepared by the University of Hawai'i

Watershed Resources & Level of Threat



Hedyotis eleator is a native plant known only from Kaua'i, growing along side of 'Ili'i'i'ula stream.

Surveys and interviews conducted by The Nature Conservancy indicate that the level of threat in Kaua'i's watershed from feral animals and invasive weeds to be high. Reducing the impact of these threats across the watershed is of primary importance to the continued health of the island's water supply.

Different areas within the Kaua'i watershed contribute differently to the protection goals of the KWA. For example, areas with the highest annual rainfall feed large and important aquifers, streams, or watersheds, and should be high priorities for protection and management. In addition to hydrological considerations, native forest quality, diversity, and manageability are also important considerations to the land-owning partners, and reflect the general conviction that preserving the island's native forests is key to maintaining a healthy watershed. Other factors considered in identifying priority management areas include accessibility and feasibility of abating threats.

A questionnaire distributed to Kaua'i landowners identified feral ungulates (such as pigs and goats) and invasive alien plants as the two most important threats to the watershed. Other secondary threats included rats, disease, erosion, and fire.

The Kaua'i watershed is delineated into three primary management designations: *Core 1 (Highest Priority)*, *Core 2 (Second Priority)*, and *Buffer Areas (Third Priority)*. Each of the three Core 1 and seven Core 2 management areas differs in its hydrologic and biological values, as well as level of threat and ownership status (Figure 5).



Upper Lumaha'i Valley is designated highest priority for management action.

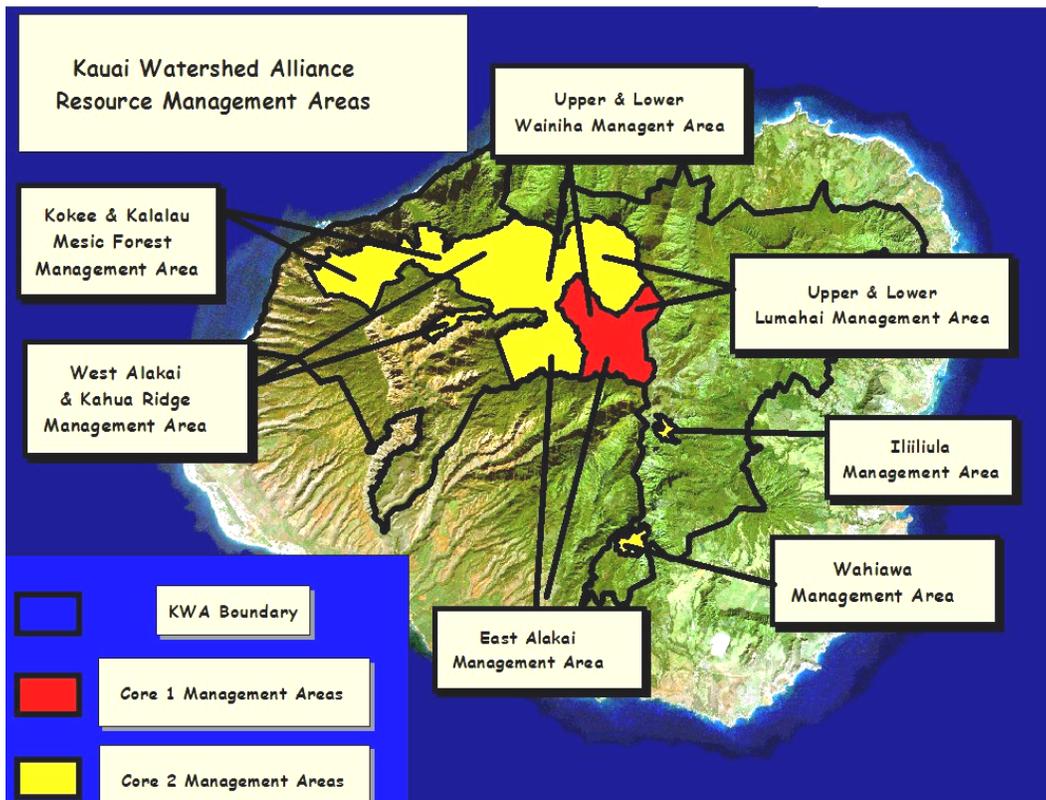


Figure 5. The map of resource management areas (left) indicates Core 1 areas in red and Core 2 areas in yellow. Core 3 areas (the remaining portions of the KWA lands) provide important buffer zones for the central active management region.

Weed abbreviations:
 ATF = Australian tree fern
 KG = Kahili ginger
 SG = Strawberry guava
 FB = Florida blackberry
 MC = *Miconia calvescens*
 CH = *Clidemia hirta*

Owner abbreviations:
 KS = Kamehameha Schools

KAUA'I WATERSHED ALLIANCE MANAGEMENT PLAN - APRIL 2005

Table 1. Core 1 Management Areas

Area Name	Hydrologic Value	Biological Value	Ungulates Threat	Weeds Threat	Area Ownership	Size (acres)	Notes
East Alaka'i A4	Very high	Very high	High	Low to moderate	McBryde; some state	2,017	<ul style="list-style-type: none"> Highest recorded rainfall on earth; central position in watershed Montane wet forest of very high ecological value Relatively intact condition Excessive pig damage according to aerial surveys & USFWS reports Remoteness precludes consistent hunting pressure ATF present throughout; KG and SG in adjacent areas
Upper Wainiha	Very high	Very high	Low to moderate	Low	McBryde	3,351	<ul style="list-style-type: none"> Position in upper watershed; very high annual rainfall Remarkably intact lowland wet forest and perennial streams Relatively little ungulate damage, but densities could increase with future ingress and lack of adequate hunting pressure Some ATF; CH present in very low numbers McBryde has a surrender agreement to the state
Upper Lumaha'i	Very high	High	High	High	KS	1,346	<ul style="list-style-type: none"> Position in upper watershed; high annual rainfall Native lowland wet forest and perennial streams Extensive pig damage along stream; large goat population Dense stands of ATF and other problematic weeds

Table 2. Core 2 Management Areas

Area Name	Hydrologic Value	Biological Value	Ungulates Threat	Weeds Threat	Area Ownership	Size (acres)	Notes
East Alaka'i A3	Very high	Very high	High	High	State; DOFAW mgmt	4,441	<ul style="list-style-type: none"> Rainfall between 2,000 and 6,000 mm/yr Intact montane wet forest Unsustainable pig damage Lack of consistent hunting pressure Outlying KG patches with limited distribution; ATF present throughout
Lower Wainiha	Medium to high	Medium	High	High	McBryde	4,918	<ul style="list-style-type: none"> Important streams Lower rainfall rates Some native forest; mostly non-native Pig damage along stream banks SG, CH present; potential to spread upstream
Lower Lumaha'i	Medium to high	Medium	Very high	High	KS	3,786	<ul style="list-style-type: none"> High quality streams Lower rainfall Mixed native/non-native forest High pig and goat densities; source for ingress to upper valley SG, CH present; potential to spread into upper valley
West Alaka'i A3	High	High	High	High	State; DOFAW mgmt	6,065	<ul style="list-style-type: none"> Large contribution to numerous streams Medium to high rainfall Intact and diverse montane wet forest Ground-based surveys detected moderate to severe ungulate damage Large patches of KG in some sites; potential to spread further into east Alaka'i
Kōke'e Mesic Areas	Low	Very high	Very high	Very high	State; DOFAW mgmt	1,588	<ul style="list-style-type: none"> Lower rainfall and limited contribution to aquifer recharge and stream yield Contains some of the best examples of native mesic forest in the state Ground-based surveys detected severe ungulate damage Large patches of KG and SG throughout the area
Kohua Ridge A2 & A3	Medium	Medium	Very high	Very high	State; DOFAW mgmt	794	<ul style="list-style-type: none"> Upper tributary of Waimea River Some intact montane mesic forest Ground-based surveys detected very severe ungulate damage throughout KG, SG, FB present in dense patches
Wahiawa Drainage and 'Ili'i'ūla	Medium	Very high	Moderate to high	Moderate to high	McBryde Sugar (Wahiawa) Līhu'e ('Ili'i'ūla)	974	<ul style="list-style-type: none"> Small area but high rates of rainfall and feeds important streams Contains last remaining lowland wet bog Highly diverse intact lowland wet forest Ground surveys detected extensive pig damage in Wahiawa; not as much in 'Ili'i'ūla SG, MC present in lower portions of Wahiawa; Upper 'Ili'i'ūla has fewer weeds; Lower 'Ili'i'ūla is considerably weedy



Weed management is time-consuming, expensive, and labor intensive, but ultimately satisfying.

Highest Priority - Core 1

Highest priority areas for management lie at the heart of the Kaua'i watershed, receiving the greatest amounts of rainfall and feeding most of the large aquifers and streams. These areas also contain high to very high quality native forest. Although these remote areas require helicopter access, most of the topography is traversable. Three small units comprise Core 1 (Table 1).

The Kaua'i Watershed Alliance should ensure the implementation of strategic and effective management actions in Core 1 areas.



The Core 2 areas are often quite intact and biologically rich, but lie in drier portions of the island. They represent the important areas for management once the Core 1 areas are stabilized.



Core 1 management areas contain intact native vegetation structure in a high rainfall setting.

Third Priority - Buffer Areas

Alien-dominated forests of strawberry guava, *Rhodomirtus tomentosa*, *Melastoma candidum* and other alien plant species dominate the non-core buffer areas. These lower-quality forests also support large populations of feral ungulates that disperse into the core. *Miconia calvescens* is also present in a few small populations with the potential to spread into the core. The KWA should encourage increased access for public hunting and support efforts to control *Miconia*. Large-scale and more intensive management actions in these areas should occur as determined by the Alliance.



Cyanea leptostegia is one of hundreds of endemic species relying on the intact habitat of Core 2 mesic forests.

Second Priority - Core 2

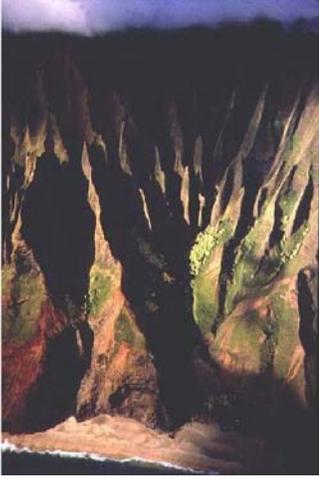
Second priority Core 2 areas lie mostly to the north and west of Core 1 and contain medium to very high quality native forest with medium to very high biological diversity (Table 2). Some areas receive a considerable amount of rainfall. Although these areas are less remote than Core 1 areas, several of them still depend on helicopter access for effective management.

The Kaua'i Watershed Alliance should consider implementation of strategic and effective management actions in Core 2 areas, as Core 1 areas are stabilized.



Clidemia hirta in the 3rd priority buffer area.

Review of Existing Management



Much of the KWA area is rugged and requires skilled and serious application of best management practices.



Asplenium polydon is only found on the islands of Kaua'i and Ni'ihau.



The endemic tree *Charpentiera elliptica* is commonly found growing up to six meters tall in the Kōke'e area.

Over half of the KWA is in State ownership under conservation zoning, with a designated Wilderness Preserve, and two Natural Area Reserves dedicated specifically to biodiversity conservation. State lands under management also include the Kōke'e, Waimea Canyon, and Nā Pali Coast State Parks. Direct stewardship in other state-owned conservation lands focuses on wildfire prevention and facilitation of public hunting and recreational hiking.

Four other major private landowners (McBryde Sugar Company, Kamehameha Schools, Princeville Development, and Grove Farm) have various small scale management programs focused on managing access, preventing fire, and a few low impact commercial hikes and tours.

Small portions of the Ku'ia and Hono o Nā Pali State Natural Area Reserves and the Alaka'i State Wilderness Preserve receive some management for protection from ungulates and prevention of new weed species by the State Division of Forestry and Wildlife (DOFAW) and their cooperators such as the Kaua'i Invasive Species Committee and the Kōke'e Resource Conservation Program, a private non-profit program under the oversight of the Kōke'e State Park. The U.S. Fish and Wildlife Service (USFWS) maintains several small enclosures to prevent ungulate incursion within the Alaka'i Wilderness Preserve.

The Nā Pali Coast State Park is heavily utilized for wilderness camping and hunting of introduced goats. Within this Park, stewardship of small sites for rare plant protection occurs on a sporadic basis.

The National Tropical Botanical Garden, based on Kaua'i, is active in the location and propagation of imperiled plant species.

The Kōke'e Resource Conservation Program (KRCP) addresses a critical need for the region. KRCP, is a collaborative project in vegetation management that started as a pilot project in 1998 by Hui o Laka and Kōke'e Natural History Museum in cooperation with the Hawai'i State Department of Land & Natural Resources (DLNR) Division of State Parks. It involves coordination of volunteers that perform alien plant management. KRCP's use of volunteers gets the job done as well as heightens public awareness of the need for partnerships and community-based management of the unique ecosystems of Kōke'e.

The Kaua'i Invasive Species Committee (KISC) is a voluntary partnership of government, private, and non-profit organizations, and concerned individuals working to prevent, control, or eliminate the most threatening invasive plant and animal species to Kaua'i's native biodiversity. KISC has a well developed management plan that includes several of the top threats to the KWA area. KISC has the potential to be a strong resource for the KWA and strong mutual benefits would be gained from collaboration.



Primary Threats

Alien Animals and Plants



Feral animals such as pigs (right) disturb groundcover and facilitate the spread of invasive plants, such as strawberry guava (above and below).



The greatest current threat to the native forests and watershed of the KWA area is a combination of the destructive effects of non-native animals, such as pigs, goats, cattle, and deer.

Some weeds and feral animals are well-established in the watershed. Pigs are virtually throughout the area except on steep cliffs; goats are in many areas (including steep cliffs); and black-tail deer are in northwestern sections of the watershed.

Hurricane damage will recur on Kaua'i, perhaps at greater frequency than on the more southerly Hawaiian high islands. We must expect that this will continue to set back native vegetation in some areas by encouraging gap-filling weeds.



These non-native animals damage the vegetation structure, introduce diseases, and open the way, via groundcover disturbance, for plant pests such as Strawberry guava, *Clidemia*, *Melastoma*, Australian tree fern, *Miconia*, and Kahili ginger. Native forests cannot withstand the effects of large land mammals, whose browsing, rooting, and trampling destroy vegetation, accelerate erosion, pollute the water supply with silt, feces, and disease, and create disturbed areas in which weeds can establish and spread. Some of these weeds have completely displaced diverse assemblages of native plants and replaced them with monocultures.



Other threats

Fire is another major threat to native resources in the western, drier portion of the watershed. Lately, there has also been an increase in human disturbances, including trespass and damage to watershed lands from uncontrolled recreational motorcycle riding, illegal collecting of plant material, illicit cultivation of marijuana, and unauthorized blazing and extension of hiking trails deep into the watershed. These actions can be curtailed through increased education and outreach efforts.



Lysimachia daphnoides is found in Wahiawa Bog and vegetation islands in the Alaka'i Swamp on Kaua'i. It is threatened by ungulate trampling.

Two severe hurricanes in 1982 and 1992 caused widespread disturbance of native vegetation and accelerated the spread of established weeds over a large portion of the Kaua'i watershed, especially along its edges. By disrupting access roads, hunter trails, and management programs, these hurricanes also caused feral animals to increase in numbers in some parts of the area that had previously been only lightly damaged.

Ungulate Management Program



Feral pigs root up ground to forage for soil fauna and plant roots.

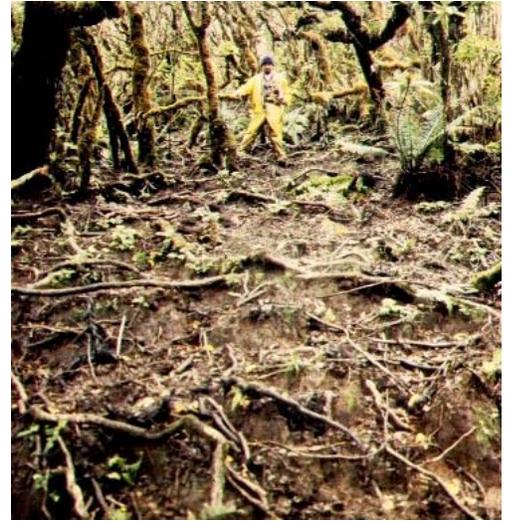


Feral goats can affect even the steepest areas.

Ungulate management goal:
Maintain or improve the structure and composition of the watershed's forest by intensively reducing ungulates in Core 1 management areas and managing ungulates in Core 2 management areas.

It has long been recognized that non-native ungulates are a primary threat to native watershed forest. Managing ungulates across the large and rugged terrain of the primary watershed of the island of Kaua'i requires a strategic plan and current information about where these threats are greatest. Information gathered from ground and aerial surveys, landowners, resource managers, and hunters formed the basis of the ungulate management plan. In addition, simulations using the *Vortex* simulation model were used to better understand ungulate population dynamics, particularly for pigs.

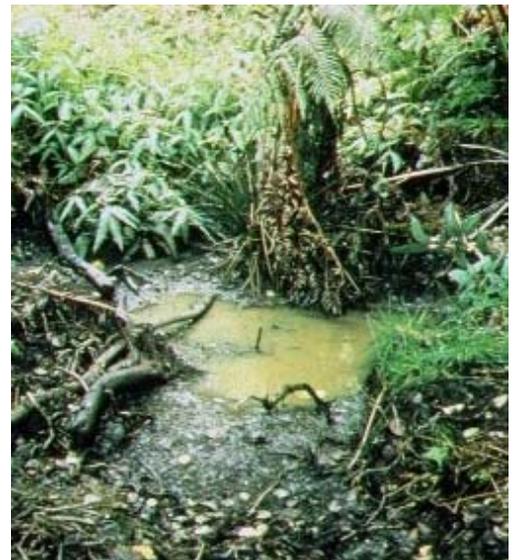
Such information helped develop various management scenarios toward realistic and effective objectives across the landscape.



Without pig management in native wet forest, loss of watershed integrity and increased erosion will occur.



Ungulate management in the remote central highlands of Kaua'i is a tremendous management challenge.



A large wallow dug by a feral pig is a breeding ground for mosquitoes that spread diseases to native birds.

Priority ungulate species



Dead pig lying in 'Ili'ili'ula stream. Feral pigs are the number one management priority in the Kaua'i watershed because of their ability to spread water-borne diseases such as leptospirosis, and their damaging foraging behavior.

Differences in the biology and behavior of problematic ungulate species result in significantly different impacts to watershed resources and processes. Some ungulate species may have serious impacts on a particular forest type, with less impact to other forest types. Characteristics such as habitat preference, reproductive biology, and foraging behavior all play a role in influencing potential damage.

Feral pigs pose the greatest threat to wet forest types, because they reproduce very rapidly, and forage by digging and upturning the ground to access roots and soil fauna.

Goats, although sometimes present in wet forests, prefer drier ecosystems, reproduce at a slower rate, and browse vegetation. However, their impact on steep slopes along the fringes of the core watershed areas can be severe.

Deer, in contrast, can thrive in a variety of ecosystem types. They are also browsers, causing relatively little soil disturbance while numbers are low, but have significant impact on preferred plant species.



Browsing by goats greatly impacts native vegetation reproduction.



Black-tailed deer were introduced to Kaua'i in 1961.

For the purpose of maintaining the hydrologic function and the ecological integrity of the core watershed areas and native ecosystems, ungulates are prioritized for management as follows:

Ungulate management priorities:

Pigs
(*Sus scrofa*)

Goats
(*Capra hircus*)

Deer
(*Odocoileus hemionus*)



Ungulates threaten many native plants, like this *Cibotium glaucum*.

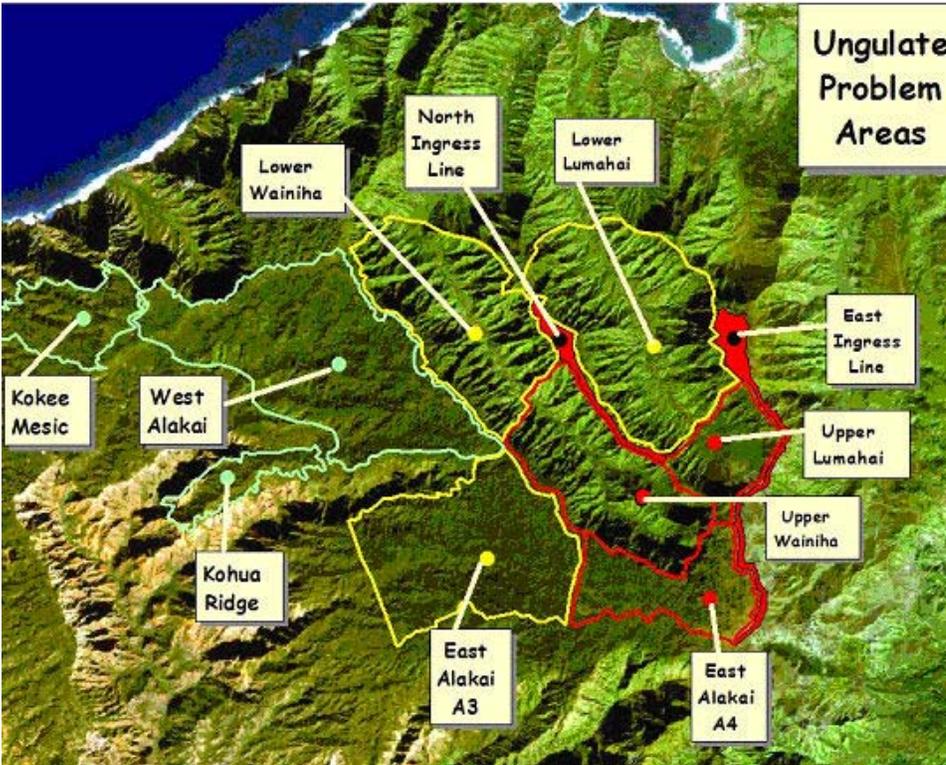


Figure 6. Within the Kaua'i watershed, nine ungulate management areas have been identified and assigned to one of three categories, Core 1 Remote (red), Core 2 Semi-accessible (yellow), and Core 2 Accessible (green).



Ungulate management areas

There are three primary areas of the watershed that warrant immediate and strategic ungulate management: Core 1 remote, Core 2 semi-accessible, and Core 2 accessible. These areas contain both valuable ecological and hydrological assets, as well as unsustainable levels of ungulate damage.

A combination of factors influence these areas: inadequate hunting intensity, frequent ingress from areas of high ungulate density, hunting pressure driving pigs into remote and sensitive native habitat, and lack of effective management methods.

The three priority ungulate management areas were determined with information from ground surveys, interviews with knowledgeable individuals, and a review of project reports from bog fence projects and other surveys in these regions. Defining three core areas based on accessibility and watershed value helps define both the type and the intensity of management effort applied across the watershed.

Table 3. Characteristics of priority ungulate management areas.

Unit Name	Areas Included	Size (acres)	Accessibility
Core 1 -- Remote	Upper Lumaha'i, Upper Wainiha, East Alaka'i A4	6,714	Helicopter access only, difficult to maintain regular hunting pressure.
Core 2 -- Semi-accessible	East Alaka'i A3, Lower Wainiha, Lower Lumaha'i	13,145	Existing / potential trails for some access, long, arduous hiking, difficult to maintain regular hunting pressure.
Core 2 -- Accessible	West Alaka'i, Kohua Ridge, Kōke'e Mesic	8,447	Roads and trails provide easy access to most areas, able to maintain regular hunting pressure.

Ungulate management approach



East Moloka'i Watershed Partnership fence crew constructing fence in montane wet forest.



Waterfalls are natural barriers for ungulate and usually do not need to be fenced.

Ungulate management and eradication has occurred in Hawai'i for over a century, especially during the territorial period when early foresters aggressively removed ungulates from upper watershed areas.

More recently, government and non-government agencies such as the National Park Service (NPS), the U.S. Fish and Wildlife Service (USFWS), the U.S. Army and Navy, the State Division of Forestry and Wildlife (DOFAW), and The Nature Conservancy (TNC) have engaged in ungulate management on each of the main Hawaiian islands with varying degrees of success. This extensive and long-term experience has confirmed that there are four essential components of a successful ungulate management program:

- *Construct barriers* to isolate populations (e.g., strategic fences);
- *Remove population* at rates significantly greater than replenished by reproduction and ingress;
- *Inspect and maintain barriers* frequently and effectively;
- *Monitor* for signs of increasing population and respond quickly.



Volunteer hunters are flown into Pelekunu Valley.

Other alternative means of animal reduction will be considered, after public hunting and staff hunting have been exhausted.



Intact native forest in the Alaka'i with a thriving native fern understory.

Ungulate management objectives



North falls of 'Ili'i'i'ula on the cliffs draining the Alaka'i. Maintaining the integrity of the East Alaka'i forest maintains water quality for the eastern districts.

Ungulate management objectives were based on the following information: (1) recent ground surveys and interviews, (2) a thorough review and analysis of ungulate management programs throughout the state, (3) current DOFAW game management guidelines, and (4) mathematical simulations of various management scenarios using the *Vortex* population model.

A detailed operational plan to manage ungulates in the Kaua'i Watershed is provided in Volume 2

Objective (1) - Intensively reduce ungulate numbers from Core 1 remote management areas.

Objective (2) - Suppress ungulates in both semi-accessible and accessible Core 2 areas.

Objective (3) Foster more effective ungulate management outside core areas.



Delicate and rare plants such as this native mint of Wainiha cannot survive if feral pigs are present.

The forested ridges of Upper Lumaha'i Valley (right) offer good fence routes.



Ungulate management budget - 6 years

Objective (1) - Intensively reduce ungulate numbers from Core 1 remote management areas.

Capital Costs (fencing & animal eradication)	
Fence Construction (ingress barrier)	\$613,000
Slinky Fence Installation (ingress barrier)	\$180,000
Volunteer Hunting Program (initial suppression)	\$65,000
Continual management with alternative means	\$290,000
Total capital costs	\$1,198,000

Operational costs	
Fence and field equipment maintenance	\$180,000

Objectives (2 & 3) - Suppress ungulates in both semi-accessible and accessible Core 2 areas and promote improved management outside core areas.

Capital Costs	
Campsites & supplies	\$38,000

Operational costs	
Volunteer Hunting Program (including coordinator salary, helicopter time)	\$410,000

Grand Total Capital = \$1,236,000
Grand Total Operational = \$ 590,000



Delicate fern and moss understory such as this is easily disrupted by feral pigs, damaging watershed function.



If our investment in watershed protection is successful, important native watershed areas such as Wainiha (right) will remain pristine.



Strawberry guava has displaced thousands of acres of native wet forest on all of the main islands.



Australian tree fern is displacing native hāpu'u tree ferns in Lumaha'i Valley.



Miconia has utterly destroyed the wet forests of Tahiti: a very similar island system to Kaua'i.

Weed Management Program

Weed management goal:

To maintain or improve the structure and composition of the watershed's forest by containing, eradicating, and excluding priority habitat-modifying weeds.

Controlling invasive plants across the large and rugged terrain of the primary watershed of the island of Kaua'i requires a well conceived process informed by current information from the field. From November 2003 - June 2004, numerous ground and aerial weed surveys were conducted by The Nature Conservancy (TNC).

Knowledgeable resource managers were also interviewed, including staff from DOFAW, KISC, and KRCP. The information gathered during this process formed the basis for this plan.

Priority weed species

Although numerous weed species exist throughout the core watershed, some have a proven detrimental effect on watershed forest structure and function.

Priority weed species can:

- Establish and survive in undisturbed native forest;
- Disperse long distances via wind or birds;
- Affect large portions of core areas;
- Grow and reproduce rapidly and prolifically;
- Displace native vegetation; and
- Convert diverse assemblages of native vegetation to monocultures of alien vegetation.



Kahili ginger is an extremely invasive understory weed and a first priority species for management.

Priority weeds for management possess all of these characteristics, and unless we engage in urgent and sustained management actions, they will irreversibly convert core native forests within the next few decades. The feasibility of successfully controlling these weeds diminishes exponentially as weeds spread beyond controllable levels. Immediate, aggressive, and strategically implemented management actions are essential to minimize long-term costs and, more importantly, maintain the integrity of the current forest. Based on the above criteria, surveys, and interviews, five weeds were determined to pose the greatest threats.

Weed management priorities:

Kahili ginger

(Hedychium gardnerianum)

Australian tree fern

(Sphaeropteris cooperi)

Strawberry guava

(Psidium cattleianum)

Miconia

(Miconia calvescens)

Koster's curse

(Clidemia hirta)



Bushy beardgrass and faya tree often grow together in a weedy assemblage.

Other weed species are also problematic in specific areas even though they do not possess all the aforementioned characteristics. These species were ranked as second priority species. They may be identified as priorities only in certain management areas, and ongoing surveys and assessments may add additional species to the list.



Rosemyrtle (above) and Banks Melastoma (below) were both introduced as an ornamentals, but are now growing out of control in the lowland watershed of Kaua'i.



- Secondary weed management priorities:**
- Prickly Florida blackberry**
(*Rubus argutus*)
 - Vaseygrass**
(*Paspalum urvillei*)
 - Bushy beardgrass**
(*Andropogon condensatum*)
 - Downy rosemyrtle**
(*Rhodomyrtus tomentosa*)
 - Banks melastoma**
(*Melastoma candidum*)
 - Faya tree**
(*Morella faya*)
 - Lantana**
(*Lantana camara*)
 - Molasses grass**
(*Melinis minutiflora*)



Blackberry is a problem in the Kōke'e and Alaka'i areas. Thorns injure hikers and impede management efforts.



Weed management areas

Core areas of the watershed were prioritized for weed management actions according to the intactness of the native forest, diversity of the native biological resources, hydrological value, and urgency of the threat. Weed management should be applied to areas with a high feasibility of success and reasonable cost. High-priority weed management areas in the watershed were identified (Figure 7).



Some areas, such as the back of Wainiha, are remarkably weed-free. The goal in such places is weed exclusion and prevention.

Weed management approach

Effective management of weeds in the Kaua'i watershed demands a strategic, systematic, and comprehensive approach, and includes mapping weed distributions, updating and storing spatial data, and using this information to adaptively manage priority areas.

Mapping and data

Currently, the most effective approach to mapping weeds in the Kaua'i watershed combines helicopter-based surveys with ground-based follow-up surveys. Aerial surveys entail flying at low speeds just above the tree canopy along transects spaced at 100-meter intervals. All first and second priority weeds and other threats (e.g., pig disturbance) are mapped with a hand-held GPS unit and entered into a GIS database. As of June 16, 2004, KRCP, KISC, and TNC surveyed 7,666 acres in the central portion of the Alaka'i Wilderness Area.

Ground-based surveys then focus in specific problem areas identified by the aerial surveys and can be conducted concurrently with weed removal operations. During ground-based surveys and all other field operations, managers collect spatial data in remote areas using GPS. All information is compiled into a GIS and disseminated to the KWA partners and appropriate field staff at periodic intervals to inform ongoing management efforts.

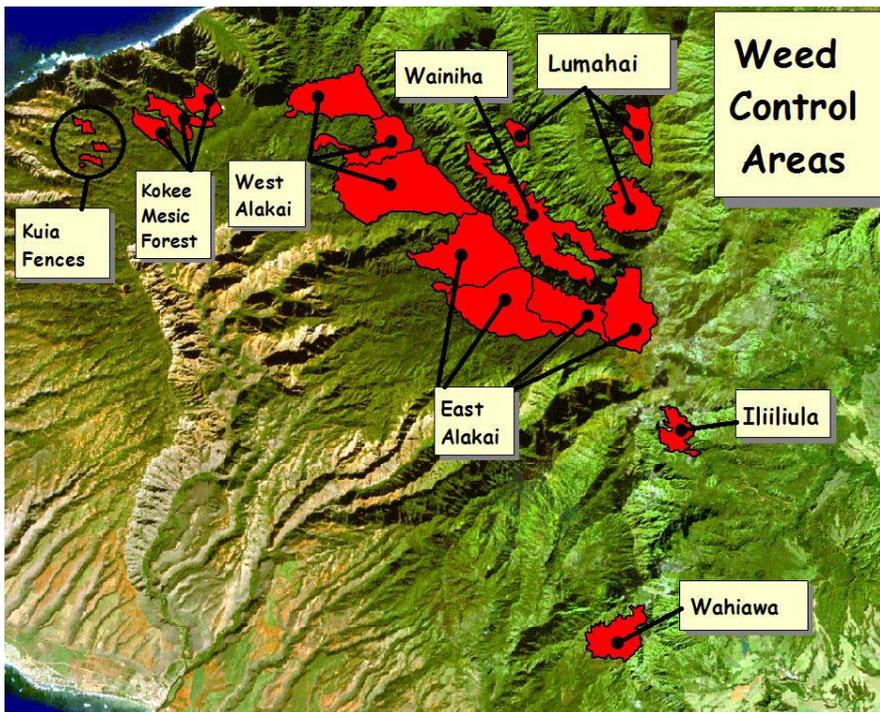


Figure 7. There are eight weed management areas identified in the management plan.



Helicopter aerial surveys for priority weeds will be followed by ground surveys and weed management measures.



Hāhā (*Cyanea hirtella*), a Kaua'i endemic plant growing along Mōhihi Stream in the Alaka'i Wilderness.



The rare native begonia aka'aka'awa (*Hillebrandia sandwicensis*) would be easily displaced by Kahili ginger.



Cyrtandra kealiiae ssp. *urceolata*

Adaptive management actions

Because of great differences among management areas, specific objectives and methods should be set for each area.

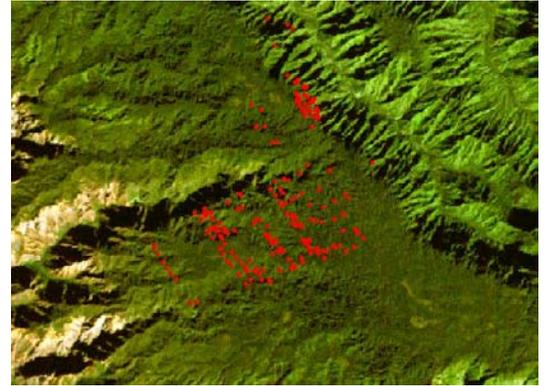
Suppression is the primary objective where the target weed is widely distributed in large patches with surrounding outliers. This involves eliminating reproductive, larger patches.

In contrast, **containment** is the primary objective where the target weed is distributed in many small patches with very few large patches. This involves treating reproductive, small, outlying patches and mapping larger patches.

If the target weed is sparsely distributed and is found only in very small patches, **eradication** is the primary objective. This involves surveying and removing all individuals.

Finally, **exclusion** is the main focus if the target weed has not yet been detected in the area. This involves conducting surveys in 3-year intervals to detect incipient patches.

Most weed management actions in high priority areas will concentrate on containment, eradication, and exclusion. This combined approach, called "quick sweep," is more appropriate for large landscapes because field personnel move rapidly, only removing weed patches with a high potential to spread, and keeping overall costs relatively low.

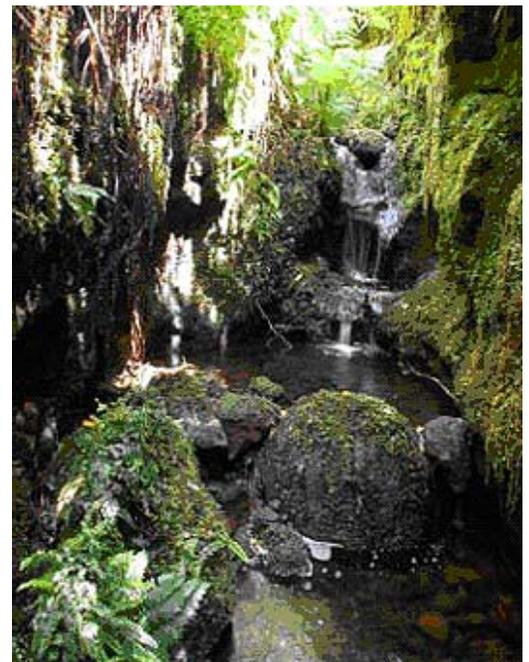


GIS mapping of weed locations on the Alaka'i reveal some serious infestations of priority weeds such as Kahili ginger.

Weed management objectives

Objective (1) - Develop accurate and complete distribution maps and a GIS database for all priority weed species.

Objective (2) - Implement adaptive management actions to suppress, contain, eradicate, and exclude high priority weeds in the highest priority management areas.



In the most weed-free areas, the goal is exclusion of priority weeds and eradication of any weeds documented during surveys.

Weed management budget – 6 years



Upper Lumaha'i Valley, includes native forest watershed with infestations of priority weeds.

Objective (1) - Develop weed distribution maps and GIS database for priority weed species.

Capital costs (one-time costs)	
Aerial surveys (includes helicopter & staff time)	
Wainiha	\$11,054
Hanalei, "Blue Hole" (cost share w/ KISC <i>Miconia</i> project)	\$49,880
'Ili'ili'ula & Wahiawa	\$9,455
GIS Equipment (hardware, software, imagery)	\$15,000
Total capital costs	\$85,389
Operational costs	
GIS technician (salary + benefits for 6 years)	\$300,000
Total operational costs	\$300,000



Māmaki (*Pipturus ruber*) is a Kaua'i endemic shrub that grows along intact stream beds.

Objective (2) - Implement adaptive management actions in highest priority management areas.

Capital costs (one-time costs)	
Vehicle purchase (one-time 4x4 truck purchase)	\$60,000
Equipment (one-time purchase camping gear, GPSs, etc.)	\$11,000
Total capital costs	\$71,000
Operational costs	
Field personnel cost - (based on person-days/acre)	\$614,486
Travel cost (helicopter time and hiking time)	\$540,225
Vehicle fuel & maintenance	\$40,000
Supplies (herbicide)	\$77,000
Total operational costs	\$1,271,711

Grand Total Capital = \$156,389

Grand Total Operational = \$1,571,711



Watershed Monitoring Program

Watershed monitoring goal:
Measure the efficacy of the management actions outlined in the KWA plan and determine if these actions are improving the hydrological and ecological integrity of the watershed.



Monitoring threat reduction, ecosystem health, and water quality across the core watershed is a challenging goal.

The KWA monitoring program combines threat abatement monitoring with vegetation and turbidity monitoring. Together, the monitoring program assesses the short-term effectiveness of ungulate and weed management and the long-term changes in the structural and functional integrity of the watershed's native ecosystems.

Ungulate monitoring

Ungulate monitoring will directly evaluate the performance of ungulate management actions while providing short-term feedback to the KWA partners and managers to inform adaptive management.



Ungulate activity monitoring will comprise the majority of the KWA's monitoring efforts. Methods proposed are based on those used by the East Maui Watershed Partnership. Ungulate activity monitoring will occur along belt transects. These transects will be placed along existing Hawai'i Forest Bird (HFB) Survey transects, or along stream corridors and hunter trails reducing the need to install new transects.

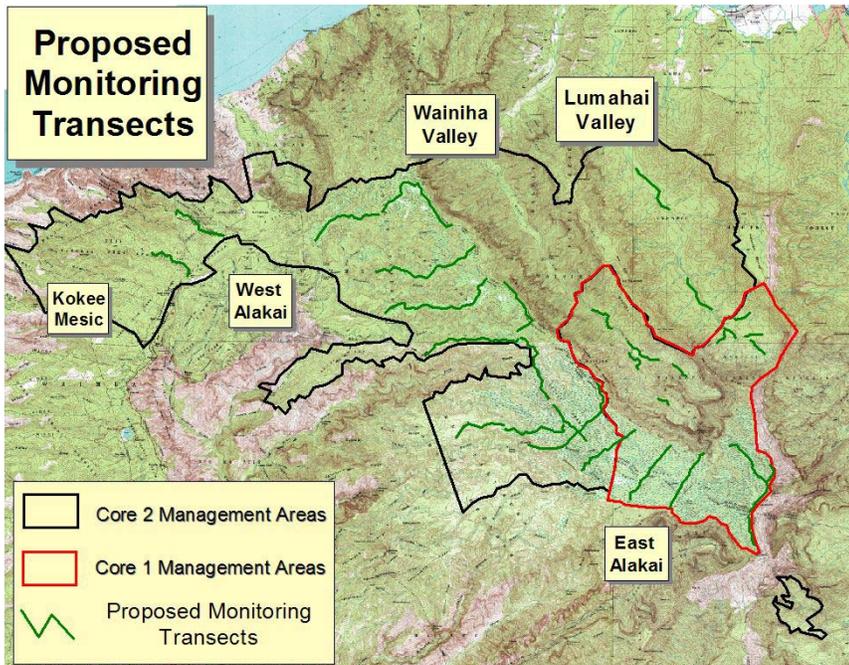


Figure 8. A network of monitoring transects will allow teams to assess the effectiveness of management and the health of the watershed. Ungulates, weeds, and ecosystem health measures will be gathered at regular intervals.

Managers will record, at a minimum, the presence or absence of pig sign within each plot and report the percent of plots with sign in each transect to give an overall activity percentage for each year. This simple method eliminates subjectivity and produces consistent and repeatable results independent of staff changes. Transects will be monitored annually during the season with the highest activity levels. Hawai'i Forest Bird Survey transects are located throughout the watershed and provide good spatial coverage in all native ecosystems and priority management units (Figure 8). In addition to the transect data, managers will map and report ungulate sign sighted during routine management actions.

Weed monitoring

Aerial surveys will be the primary means of measuring the effectiveness of weed management actions. After initial baseline aerial surveys are complete, additional aerial surveys along randomly selected transects planned at 100 m apart, should continue on 5 to 10-year intervals, starting with the central Alaka'i in 2010. Additional aerial surveys will be scheduled when needed to gauge progress on specific weed management activities. Other weed distribution data, collected from field personnel during ground-based operations will be compiled in the GIS.



"Quick sweep" operations would efficiently combine detection, exclusion, and eradication.

Vegetation monitoring

Detecting changes in native ecosystems at large spatial and temporal scales is difficult due to their inherent variability and slow rate of change. However, focusing on specific parameters such as vegetation cover over long periods of time should detect basic trends in ecosystem integrity.

Monitoring changes in vegetation cover will rely on 16-meter diameter permanent circular plots placed near existing transects and trails throughout priority management areas. Managers will record absolute percent cover for native and non-native vegetation species in 6 classes: tree, shrub, fern, grass & sedge, vine, and bryophytes, as well as percent ground disturbance and the presence or absence of seedlings. Sampling in each plot should occur every 5 - 10 years, and the monitoring program should take place concurrent with ungulate monitoring to save on cost.

In addition to the vegetation cover plots, high-resolution aerial imagery can detect changes in the canopy cover over longer time periods. While currently available imagery is only capable of identifying obvious vegetative contrasts (*e.g.*, forest vs. grassland vs. bare ground), future advances in imagery and analysis techniques should identify native vs. non-native vegetation.



Monitoring vegetation health in the core watershed (right) will compare native vs non-native canopy trees and groundcover plant species.

Stream turbidity monitoring

Successful large-scale ungulate and weed management will lead to improvements in vegetation cover and declines in ground disturbance, and should result in decreased stream turbidity. Since stream turbidity is an indication of excessive over-land flow or runoff, a reduction in turbidity can be equated with improved infiltration and aquifer recharge.

Currently, no watershed-scale system to assess stream turbidity exists on Kaua'i; however plans to deploy an array of environmental sensors, transmitters, and repeaters, including stream turbidity sensors, are underway. The monitoring program is funded through a National Science Foundation (NSF) program called EPSCOR, awarded to the University of Hawai'i's Center for Conservation and Research Training (CCRT). The program seeks to provide useable information to better understand and manage watershed conditions and functions.

Currently, the development and refinement of monitoring techniques is occurring in the Halele'a District on the north shore of Kaua'i. However, the potential exists to expand the system of sensors and repeaters to the Alaka'i and other core management areas. The KWA should encourage and support CCRT's efforts to deploy the system in core areas of the upper-watershed, where most of the direct threat abatement actions will occur.



Clear-running streams are important to native stream animals such as 'ōpae.



Monitoring stream condition and function is the focus of a University of Hawai'i project funded by the NSF.

Monitoring objectives and budget

Monitoring objectives were based on a recent review of monitoring programs throughout the state.

Objective (1) - Measure the effectiveness of ungulate management actions.

Objective (2) - Measure the effectiveness of weed management actions.

Objective (3) - Measure long-term changes in vegetation cover throughout core management areas.

Objective (4) - Measure long-term changes in stream turbidity throughout core management areas.

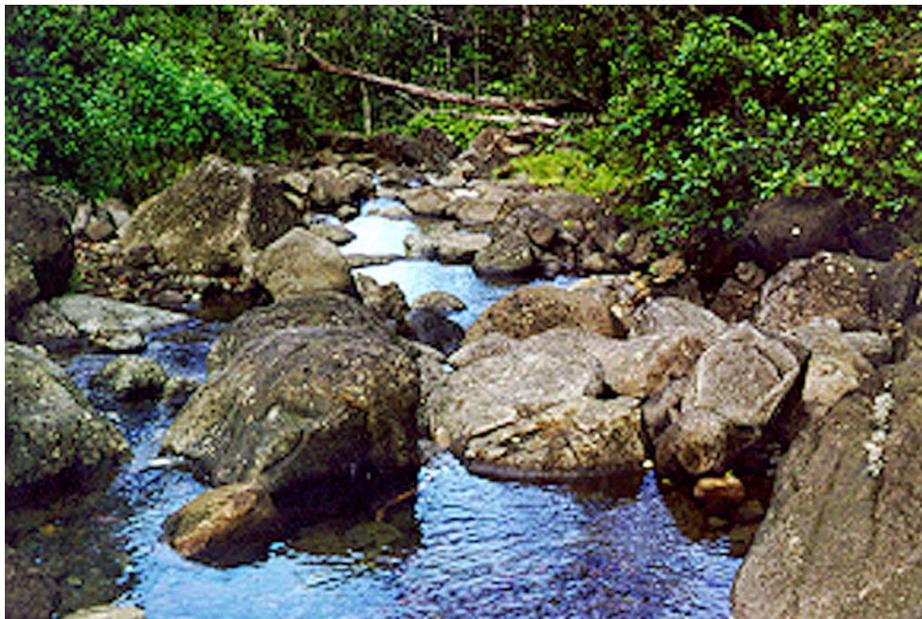


A rare kāpana mint relies on healthy forest.



Programs to monitor priority weeds such as *Miconia* are built into the plan.

Capital costs (one-time costs)	
Equipment (one-time purchase camping gear, GPSs, etc.)	\$7,000
Total capital costs	\$7,000
Operational costs	
Field personnel cost	\$90,000
Travel cost (helicopter time and hiking time)	\$30,000
Total operational costs	\$120,000



Stream turbidity is a good indicator of the health of a watershed.

KWA Infrastructure and Budget

Staffing

Currently DOFAW has the greatest number of staff dedicated to forest and watershed management among the KWA partners. However, they are spread thin over a broad mandate and area. Other partners occasionally devote staff and equipment to a few management projects in the more accessible areas of the watershed. Given the current limited staff of the partners, it is unlikely that existing personnel will be able to fully implement this plan.

Thus, additional dedicated leadership, expertise, and staffing beyond the capacity of the individual partners are recommended. Permanent staff needed can be kept to a minimum by utilizing sub-contractors. A watershed coordinator should be hired to manage the implementation of this plan, raise funds, and develop community support for management activities. A coordinator position has been essential to the success of other watershed partnerships throughout the state, including the East and West Maui, East Moloka'i, and Ko'olau partnerships. The coordinator will also ensure that project activities are coordinated with the State, private landowners, KISC, KRCP, and other groups currently working in the watershed.

The coordinator will need the support of an administrative assistant who can track and prepare budgets, attend to correspondence, and ensure fiscal compliance for grants and contracts. A field technician with GIS skills will be needed to track and update all field monitoring data, and assist with ongoing operations. Office space along with a base yard, or facility, to store equipment, supplies, safety gear, and vehicles will also be necessary in the short term.

Developing sufficient public understanding and support for KWA watershed management activities to ensure plan implementation will be an important duty of the coordinator and the KWA partners and can mean the difference between project success and failure.

Communication with key members of the public on the watershed's value, threats, and management, through small meetings and field trips will help ensure project support. In addition there will be opportunities to provide the broader community with updates on successful watershed activities via existing media (TV, radio, newspapers, magazines, the internet, etc.), and through special publications designed specifically to distribute to key audiences.

Due to costs, outreach efforts should be limited and carefully planned. Other partnerships like the East Maui Watershed Partnership and the Maui Invasive Species Committees have hired full-time public relations staff who have greatly contributed to project success. After several years, the KWA may want to consider this option depending on the level of Kaua'i community support.



Dedicated staff are needed to fully implement the management programs of the KWA plan.



Access

Much of the KWA watershed is remote with very steep and rugged terrain. Therefore many of the management actions in this plan depend on helicopter access. Some strategically placed helicopter landing zones, shelters, and low impact trails already exist but more will be needed.

Additional vehicular access roads should not be constructed within the project area since roads on steep terrain create severe soil erosion, fragment forest ecosystems, and greatly increase the likelihood for alien species introductions.

Any improvements to new or existing roads and trails should be designed and maintained to minimize unwanted impacts, such as overuse of sensitive sites, inadvertent introduction of weeds on hiker's boots or vehicles, heightened liability exposure, increased potential for damage to the water system, increased risk of contamination of the water supply, or encouragement of marijuana growing or other illegal activities.



Access to much of the Kaua'i Watershed will require helicopters and a system of landing zones.



Roads and trails should be kept to a minimum to prevent unwanted impacts.



Portable management shelters, such as this one in use in the East Maui Watershed, are part of the expanded management infrastructure necessary to conduct work in remote areas.



Fire

Fire is a major threat to KWA areas on the leeward and drier fringe areas. Although DOFAW and Kaua'i County are currently the first line of defense against fires, the KWA should identify areas where fire is likely to occur and take preventive measures to reduce fire risk. For example maintaining firebreaks in high-risk areas could prevent fire from spreading into forested areas. The KWA coordinator and any additional field support staff should be trained in basic firefighting techniques to supplement DLNR staff in case of a fire emergency. Other partnership staff should also be identified and properly trained.

Operating structure

As with other watershed partnerships throughout the state, a legal entity is needed to receive and spend funds from federal, state, and private sources to carry out the management activities of this plan. The Pacific Cooperative Studies Unit (PCSU) of the Research Corporation of the University of Hawai'i (RCUH) currently acts as the fiscal and legal agent for the other watershed partnerships. However, other contracting options are available. Services provided by the chosen coordinating entity are essential to the operation of the KWA and should include personnel, accounting, and safety oversight. This entity should also carry its own workman's compensation insurance, and provide other employee benefits.

Some partnerships have formed, or are considering forming, 501(c)(3) non-profit organizations. Non-profit organizations enable the receipt of private donations. However, the costs and administration of hiring staff through a non-profit 501(c)(3) are considerable and none of the watershed partnership has yet hired staff through their own non-profit. The KWA should consider all options available, including forming a 501(c)(3) after the first year of operation primarily to facilitate the receipt of private donations.



There are many complex fiscal and legal requirements for watershed partnership operations.

Operational objective and actions

Infrastructure goal:

To provide and maintain the appropriate staffing and infrastructure to implement the KWA management plan.

Actions

1. Hire or contract watershed coordinating services.
2. Secure adequate support infrastructure for KWA coordination: four-wheel drive vehicle; field supplies and equipment; office rent; telephone; communications; and office equipment; inter-island travel and training.
3. Develop and maintain a KWA fire emergency coordination strategy with DOFAW and Kaua'i County.
4. Identify staff training needs and schedule training opportunities.
5. Develop strong relationships with key community leaders and update key watershed stakeholders to ensure community support for watershed management activities.
6. Develop partnership case statement and public relations materials.
7. Develop four remote shelters and sites.
8. Develop operational guidelines.



Six Year Budget Summary



The lehua makanoe of the Alaka'i bogs.

The proposed budget covers six years of KWA watershed activities beginning July 1, 2005 and ending June 30th 2010 (FY2006 - FY2011). Although, costs are depicted as flat over six years, it is likely that year to year expenses will vary. Costs do not include inflation or cost of living increases. A 17.5% overhead estimate is included, though actual indirect costs may vary.

The KWA partners have a long-term vision extending beyond the six years of this plan. Additional projects will be needed to ensure the long-term protection of the Kaua'i watershed, particularly outside the core areas targeted in this plan. Projects in this plan were chosen because they are feasible priorities within six years.

Funding for the plan can be obtained through a variety of sources. Partnerships on other islands have been successful at obtaining a combination of Federal, State, County, and private funding to cover watershed project costs. Partners may choose to carryout some of this work with existing staff or partners, which may lower costs.

Base Annual Operating Costs

Watershed Coordinator	\$70,000
Administrative Assistant*	\$40,000
Field Technicians (2)	\$80,000
Field and Office Supplies**	\$20,000
Office and Baseyard Rent*	\$25,000
Inter-island Travel and Training	\$4,000
TOTAL	\$239,000

* if possible, these costs may be shared with a partner

** includes communication equipment, computers, etc

Table 4. KWA Management - Six Year Total Budget Summary

Major Budget Item	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	Total
Ungulate Management	\$569,000	\$449,500	\$337,500	\$230,000	\$120,000	\$120,000	\$1,826,000
Weed Management	\$182,460	\$210,549	\$245,261	\$297,556	\$412,637	\$379,637	\$1,728,100
Watershed Monitoring	\$22,000	\$21,000	\$21,000	\$21,000	\$21,000	\$21,000	\$127,000
Watershed Coordinator	\$70,000	\$70,000	\$70,000	\$70,000	\$70,000	\$70,000	\$420,000
Administrative Assistant	\$40,000	\$40,000	\$40,000	\$40,000	\$40,000	\$40,000	\$240,000
Field Technicians (2)	--	\$80,000	\$80,000	\$80,000	\$80,000	\$80,000	\$400,000
Administrative costs (office/baseyard rent, equipment/supplies, travel)	\$49,000	\$49,000	\$49,000	\$49,000	\$49,000	\$49,000	\$294,000
Subtotal	\$932,460	\$920,049	\$842,761	\$787,556	\$792,637	\$759,637	\$5,035,100
Est. Overhead (ca 17.5%)	\$163,181	\$161,009	\$147,483	\$137,822	\$138,711	\$132,936	\$881,143
TOTAL	\$1,095,641	\$1,081,058	\$990,244	\$925,378	\$931,348	\$892,573	\$5,916,243